City of St. Cloud: Jacob Ethen

MN TAP: Emily Champion

Treatment Facility
City of Saint Cloud Wastewater

Optimizing Energy Efficiency at
Cities Served:
- Sartell
- St. Joseph
- Sauk Rapids
- St. Augusta
- White Park

Mississippi River
Wastewater prior to discharge into the
Treats industrial, commercial, and residential
Wastewater Treatment Process

1. Pump stations
2. Pretreatment
3. Primary Treatment
4. Biological Nutrient Removal
5. Secondary Treatment
6. UV Disinfection
7. Discharge into River
8. Solids Dewatering
9. Waste Activated Sludge (WAS)
10. Biosolids Application

Return Activated Sludge (RAS)
Bacterial growth requires a concentration of 2 mg/L dissolved oxygen. Bacteria require a bacterial wastewater using phosphorous from removal (BNR) Biological Nutrient Wastewater Treatment Process.
<table>
<thead>
<tr>
<th>Black and Veatch BNR Requirement</th>
<th>BNR Requirement</th>
<th>Fine Pore Diffusers Requirement</th>
<th>Calculated Airflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.015 SCFM ft³ per sec volume</td>
<td>0.12 ft² SCFM</td>
<td>0.5 SCFM diffuser</td>
<td>7,400 SCFM</td>
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<tr>
<td>4,600 SCFM</td>
<td></td>
<td></td>
<td>3,000 SCFM</td>
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</tbody>
</table>

Minimum mixing required to prevent diffuser fouling removal.

Wastewater heuristics for biological nutrient removal.
Proprietary Dual-Point Control™

600 HP Turbplex Blowers
use Decrease energy mg/L oxygen setpoint of 2
the dissolved process to maintain Optimize aeration Surging Prevent blower
Motivation for Improvement
Trend data using SCADA software

Aeration Model

Calculate blower energy use with the

Approach
Control downstream valves (Most-open valve)

The pressure is decreased by opening

\[ \frac{h}{p} = \frac{\frac{\zeta_2}{\zeta_1}}{\zeta_3} = \frac{\zeta_2}{\zeta_1^3} \]

Fan Affinity Law

Decreasing the power consumption decreases the power differential pressure

Decreasing blowers differential pressure and power
Most-Open Valve Control Strategy
Most Open Valve Results

Decrease capacity

Allowed blower to

Surging

Eliminated blower

21.5 psia

from 22.3 psia to

Discharge pressure

Decreased blower
Pressure
Blower Differential
Dissolved Oxygen
Value Position
Variable Diffuser Position
Motor Amps

After MOV
Before MOV

Improved Process Stability
Improved Dissolved Oxygen Control
Improved DO Control Results in Decreased Air Flow

**Blower Header Airflow**

**Dissolved Oxygen**

Airflow (SCFM)

- Jan
- Feb
- Mar
- Apr
- May
- Jun
- Jul
- Aug
- Sept
- Oct
- Nov
- Dec

- 2014
- 2013

Average DO (mg/L)

- 0
- 1
- 2
- 3
- 4
- 5

- 2014
- 2013
Total energy savings in three months exceeds total blower airflow.

Energy savings are proportional to the monthly demand.

<table>
<thead>
<tr>
<th>October</th>
<th>635</th>
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<tbody>
<tr>
<td>$6,200</td>
<td>85,800</td>
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<th>September</th>
<th>674</th>
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<tr>
<td>$6,700</td>
<td>92,400</td>
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<td>546</td>
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<tr>
<td>$3,700</td>
<td>51,400</td>
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<td>572</td>
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<thead>
<tr>
<th>2013 Energy Demand (KWh)</th>
<th>2014 Energy Demand (KWh)</th>
<th>Energy Cost ($/month)</th>
<th>Savings (KWh/month)</th>
<th>Savings Cost ($/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased Energy Demand</td>
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Modelled savings from Aeratation Model

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<tr>
<th>Plant Data</th>
<th>8 DO Control &amp; Most-Open Valve</th>
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<tr>
<td>$66,500</td>
<td>960,000 kWh</td>
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<tr>
<td>$54,000</td>
<td>766,000 kWh</td>
</tr>
<tr>
<td>$27,500</td>
<td>392,000 kWh</td>
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</table>

Annual Energy and Cost Savings

Net Savings

Energy Reduced (per year)
Eliminated blower surging
Operate at lower capacity
Saved energy by enabling the blower to
concentrate
Decreased variance in dissolved oxygen
Improved existing Most-Open Valve

Successful Process Changes